NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION
STS-51F

PRESS KIT
JULY 1985

SPACELAB 2

STS-51F INSIGNIA

S85-29498 -- The space shuttle Challenger is depicted ascending toward the heavens in search of new knowledge in the field of solar and stellar astronomy, with its Spacelab 2 payload. The constellations Leo and Orion are in the positions they will be in relative to the sun during the flight. The nineteen stars signify that this will be the 19th shuttle flight. The artist was Skip Bradley of Houston.

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CONTACTS

Charles Redmond/Sarah Keegan
Headquarters, Washington, DC
(Phone: 202/453-8536)

James Kukowski
Headquarters, Washington, DC
(Phone: 202/453-1548)

Terry Eddleman
Marshall Space Flight Center, Huntsville, AL
(Phone: 205/453-0034)

David Alter
Johnson Space Center, Houston, TX
(Phone: 713/483-5111)

Andrea Shea
Kennedy Space Center, FL
(Phone: 305/867-2468)

James Elliott
Goddard Space Flight Center, Greenbelt, MD
(Phone: 302/344-6256)

Frank Bristow
Jet Propulsion Laboratory, Pasadena, CA
(Phone: 818/354-5011)

Ralph Jackson
Dryden Flight Research Facility, Edwards, CA
(Phone: 805/258-8381)

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NEW SPACELAB CONFIGURATION TESTED ABOARD CHALLENGER

Space Shuttle mission 51-F/Spacelab 2 marks the first flight of an igloo-pallet configuration and a new Instrument Pointing System. The mission is the second verification test flight and the third dedicated mission for the space laboratory developed for NASA by the European Space Agency (ESA).

This pallet-only configuration consists of unpressurized platforms (pallets) in the payload bay which, with the pointing system, turn Spacelab into a unique orbiting observatory for studying the sun, stars and space environment. An igloo, a cylindrical shell attached to the first pallet, houses many of the systems such as computers and data recorders. These systems previously have been located inside a pressurized laboratory module element flown on the two earlier dedicated Spacelab missions, but the module is not required for this flight.

Spacelab 2 is scheduled for liftoff from Launch Complex 39, Pad A, at Kennedy Space Center, Fla., on July 12, 1985, at 4:30 p.m. EDT. During the 7-day mission, Spacelab operates in the payload bay of the orbiter Challenger, circling Earth at a maximum altitude of 211 nautical miles with an orbital inclination of 49.5 degrees. Spacelab 2 is flying shortly after Spacelab 3 because of a delay in completing the Instrument Pointing System.

Since this is the first pallet-only Spacelab flight, primary mission objectives are to verify the Spacelab systems and to determine the interface capability of Spacelab and the orbiter.

A secondary, but important objective, is to obtain scientific and technology data to demonstrate Spacelab's capability to conduct investigations in a number of disciplines on a single mission. Thirteen investigations in seven scientific disciplines were chosen to exercise Spacelab's capabilities to the fullest and, at the same time, collect valuable research data.

The Spacelab 2 mission schedule is busy with research activities, and once again payload crew members perform scientific investigations continuously around the clock during two 12-hour shifts. Two of the scientists who developed Spacelab 2 solar observation experiments are payload specialists and will conduct research during the mission. Dr. Loren Acton, a solar physicist from Lockheed Palo Alto Research Laboratory in California, and Dr. John-David Bartoe, a solar physicist from the U.S. Naval Research Laboratory in Washington, DC., are the third pair of career scientists to work aboard Spacelab.

Scientific research also is performed by two NASA mission specialists: Dr. Anthony England, a geophysicist specializing in Earth and planetary sciences, and Dr. Karl Henize, an astronomer.

Commander of the seven-member crew is C. Gordon Fullerton, a veteran NASA astronaut who served as pilot on the third Shuttle mission. Assisting him are pilot Roy D. Bridges Jr., on his first Shuttle flight, and an experienced NASA scientist-astronaut Dr. Story Musgrave, who served as mission specialist on the sixth Shuttle flight.

NASA's Marshall Space Flight Center, Huntsville, AL, is responsible for overall management of the Spacelab 2 mission. This involves overseeing all aspects of the mission including experiment selection, payload crew training, mission planning and real-time mission support. The Spacelab 2 mission manager, Roy C. Lester of Marshall, works with members of the NASA centers to ensure mission success. Mission scientist Dr. Eugene W. Urban of Marshall coordinates the activities of the mission's science participants with the management team.

ESA also continues to work cooperatively with the Marshall management team and other NASA centers. ESA designed, developed and funded Spacelab to serve as part of America's Space Transportation System. Spacelab includes various standardized parts, such as habitable modules, pallets and a pointing system, that

can be assembled to meet the needs of a particular mission. The habitable module and several other Spacelab components, including single pallets, have already been used successfully to perform research in various scientific disciplines.

The Spacelab 2 configuration consists of three pallets, an igloo and a pointing system. Each U-shaped pallet is 10 feet long and 13 ft. wide and is covered with aluminum honeycomb panels. The pallets mount directly to the orbiter and experiments are attached to the pallets via different interfaces. This mission will verify that the pallet configuration, augmented by the igloo and the pointing system, is satisfactory for observations and research.

Thirteen experiment teams, 11 from the United States and two from the United Kingdom, are directing investigations in solar physics, atmospheric physics, plasma physics, infrared astronomy, high energy astrophysics, technology research and life sciences. Ten of these experiments require direct exposure to space and are mounted on the pallets and in a special support structure inside the payload bay. One experiment conducted from the ground uses the Shuttle as a research tool. Two life sciences experiments are located in middeck lockers.

Another new Spacelab component, the ESA-developed Instrument Pointing System, is being tested during its inaugural flight. On the first pallet, three solar instruments and one atmospheric instrument are attached to the pointing system, which can aim them more accurately than the Shuttle alone and keep them fixed on targets as the Shuttle moves. The pointing system has a relative accuracy of 2 arc seconds (one eighteen hundredth of a degree), which means it can remain pointed in stable fashion at an object the size of a quarter from a distance of less than one and a half nautical miles.

This mission also uses a different method for commanding and monitoring Spacelab instruments. On two previous missions, Spacelab 1 and 3, the payload crew operated instruments from inside the habitable module. This payload crew works inside the orbiter aft flight deck, located directly behind the cockpit. Equipment, such as the Spacelab computer consoles, television monitors, controls for the Instrument Pointing System, data collection and various experiments are mounted along panels in the U-shaped work area.

Many of the commands are routed through the igloo, another Spacelab component on its maiden flight. The igloo is a pressurized container that houses Spacelab subsystems for computer operations, data recording and transmission and thermal control. On previous Spacelab flights, these systems have also been located inside the habitable module. The igloo, which has a volume of about 53 cubic ft. and weighs about 1,408 pounds when fully equipped, is mounted to the front frame of the first pallet.

Verification tests of Spacelab systems and subsystems begin at launch and continue throughout the mission. Verification flight instruments measure such parameters as temperature and vibration levels in the payload bay. On the first day of flight, a special set of tests is performed on the Instrument Pointing System; it is unstowed and aimed at various solar viewing targets to verify its pointing capability and accuracy.

By approximately 15 hours into the mission, all of the Spacelab 2 science instruments are activated. Many begin making observations immediately.

On the third flight day, the crew uses the Remote Manipulator System to deploy a small subsatellite for studies of the surrounding space environment. The Shuttle makes several complex maneuvers around the satellite at a distance of about a quarter mile and then the satellite is retrieved and returned to the vicinity of the payload bay to continue making other measurements.

This is the third NASA mission in which scientists who developed Spacelab experiments participate actively in guiding the mission. These scientists, called principal investigators, helped train and select the payload specialists and worked closely with the management team to plan the mission. During the flight, they work in the Payload Operations Control Center (POCC) at NASA's Johnson Space Center in Houston.

Throughout the mission, all Spacelab 2 science operations are managed from the POCC at Johnson. Members of the Marshall mission management cadre, along with investigator teams who developed the Spacelab 2 experiments, monitor, direct and control experiment operations from the ground control center. During the mission, Spacelab systems are also carefully monitored 24 hours a day from the Huntsville Operations Support Center (HOSC) in Huntsville, AL. Both POCC and HOSC personnel work closely with the Johnson Mission Control Center (MCC) staff, which is responsible for controlling the orbiter Challenger and basic Spacelab systems. The MCC and the POCC are located in the same building.

The Tracking and Data Relay Satellite System (TDRSS) handles most of the communications and data transmissions between the spacecraft and the ground. NASA's worldwide Ground Spacecraft Tracking and Data Network, operated by the Goddard Space Flight Center, Greenbelt, Md., is used when TDRSS coverage is not available. A special Spacelab Data Processing Facility at Goddard receives the steady flow of scientific and engineering data from Spacelab.

After 7 days of around-the-clock verification tests and science operations, Challenger is scheduled to land on July 19 at Edwards Air Force Base in California. Reentry will begin with the firing of the Shuttle's Orbital Maneuvering System engines as the orbiter makes its 110th revolution of the Earth. Landing is set for 3:42 p.m. EDT, on Runway 17.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

51F BRIEFING SCHEDULE

Time (EDT)	Briefing	Origin
T-1 Day		
8:00 a.m.	Mission Overview	KSC
8:45 a.m.	Solar Physics Experiments	KSC
10:00 a.m.	Plasma and Atmospheric Physics Experiments	KSC
12:00 Noon	High Energy Astrophysics, Infrared Astronomy and Technology Research	KSC
1:15 p.m.	Spacelab 2 Middeck Experiments	KSC
2:00 p.m.	College Experiments	KSC
2:30 a.m.	Carbonated Beverage Container Evaluation	KSC
3:00 a.m.	Prelaunch Briefing	KSC
T-Day		
6:00 a.m. approximate	Post Launch Press Conference	KSC
Launch Through End of Mission		
Times announced on NASA Select	Flight Director Change-of-Shift Briefings	JSC
12:00 Noon (approximate)	Science Summary Briefings	JSC
Landing Day		
5:00 p.m.	Post Landing Briefing	DFRF

GENERAL INFORMATION

Each day there will be as many as three change-of-shift briefings by the Shuttle flight director. The Spacelab 2 mission manager will participate in one of these briefings daily. Additionally, there will be one science summary briefing by the mission scientist. Media representatives at Johnson Space Center can attend these briefings. At other NASA centers, reporters can monitor the briefings on NASA television via satellite and ask questions via two-way audio circuits.

NASA Select Television Transmission

The television schedules will be updated daily to reflect any changes in the mission. The schedule for television transmissions from Challenger and Spacelab, for mission briefings, and for interviews will be available during the mission at Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center, and NASA Headquarters. These transmission also will be carried by RCA Satcom F-1R Transponder 18 (full transponder).

NASA Select Television and Audio Release circuits will also feature special science updates between 5 a.m. and midnight each day. These periodic updates will focus on cadre members and investigators discussing experiment progress. The reports are intended to augment the real-time science information available to media. These reports will be conducted by Drs. Byron Lichtenberg and Michael Lampton (payload specialists for Spacelab 1 and Earth Observations Mission, respectively).

Satcom F-1R is located 139 degrees west longitude. Transponder 18 transmits on a frequency of 4060.0 MHz. The system will be operational 24 hours a day from T-4 hours on launch day through T+4 hours on landing day.

Mission Audio and Video

The Press will have access to real-time audio and video transmitted from the spacecraft to ground control centers. Media may obtain real-time Spacelab 2-to-POCC communications over the air-to-ground 1 circuit (A/G-1). A/G-2 will be used as the orbiter-Mission Control Center voice circuit. Occasionally, the A/G will be shared by the MCC and the POCC. In addition, Public Affairs commentary on the progress of the mission is broadcast on the Mission Audio channel.

Special Note to Broadcasters

Beginning July 10 and continuing through the end of the mission, approximately 7 minutes of audio interview material with the crew of 51-F will be available to broadcasters by calling 202/269-6572.

Status Reports

Status reports on countdown progress, mission progress, on- orbit activities and landing operations will be produced by the appropriate NASA news center. They will be posted in NASA center newsrooms. The Spacelab POCC will provide summary science status reports, plus periodic shorter reports, throughout the mission.

Transcripts

Transcripts of the change-of-shift briefings will be available at the NASA news centers.

Spacelab 2 Viewing

Spacelab 2 is one of the most visible Shuttle mission to date. From Earth, it can be viewed with the naked eye at several designated times. Maps displayed in NASA center newsrooms show the date and times on which the flight should be visible from various regions of the United States.

SHUTTLE MISSION 51-F -- QUICK LOOK FACTS

Crew: Charles G. Fullerton, Commander
Roy D. Bridges Jr., Pilot
Karl G. Henize, Mission Specialist (MS-1)
Anthony W. England, Mission Specialist (MS-2)
F. Story Musgrave, Mission Specialist (MS-3)
Loren W. Acton, Payload Specialist (PS-1)
John-David F. Bartoe, Payload Specialist (PS-2)

Orbiter: Challenger (OV-099)

Launch Site: Pad 39-A, Kennedy Space Center, Fla.

Launch Dates/Times: July 12, 4:30 p.m. EDT

Window: 2 hours

Orbital Inclination: 49.5 degrees

Orbit: Insert into 186 by 106 n. mi. (direct insertion) orbit, then maneuver to approximately 207 n. mi. circular with 7 OMS maneuvers, which also are required to meet the Plasma Depletion Experiment requirements for a ground track that passes over specific ground sites.

Mission Duration: 6 days, 23 hours, 12 minutes

Orbits: 109 full orbits; land on orbit 110

Landing Date/Time: July 19, 3:42 p.m. EDT

Primary Landing Site: Edwards Air Force Base, CA, Runway 17

Weather Alternate: Kennedy Space Center, Fla., Runway 15

Transatlantic Landing: Zaragoza, Spain

Abort-Once-Around: Space Harbor, White Sands, NM.

Payload: Spacelab 2 (see Spacelab 2 Investigations for experiments)

Additional Experiments: Protein Crystal Growth
Plant Growth Unit (PGU)
Shuttle Amateur Radio Experiment (SAREX)
Carbonated Beverage Dispenser Evaluation (CBDE)

Mission Objectives: To verify the ESA-built Spacelab pallet configuration and conduct application, science, and technology investigations that require direct exposure to space above Earth's atmosphere and accurate pointing at the sun and other celestial targets.

Flight Synopsis: The 51-F mission timeline calls for rotating shifts. Two teams, Blue and Red, work alternating shifts of 11 to six hours. The Red team comprises the PLT, MS1 and PS1; the Blue team, MS2, MS3 and PS2. The commander works either shift as needed.

Launch/Entry Seating: The commander and pilot will occupy their normal flight deck seats. MS2 (Musgrave) will sit on the flight deck behind and between the commander and}pilot. MS1 (Henize) will sit on the flight deck to the right of MS2. MS3 (England) and the payload specialists will sit on the middeck.

Contingency EVA Crewmen: Story Musgrave, Tony England

STS-51F TRAJECTORY SEQUENCE OF EVENTS

Event	Tig MET (d/h:m)	Burn Duration (min:sec)	Delta V (fps)	Post Burn Apogee/Perigee (n mi)
Launch	0/00:00			
Main Engine Cutoff (MECO)	0/00:09			
Insertion Burn	0/00:39	0:1.45	160.2	186x106
PDP Experiment -- 7 OMS Burns Performed Over:				
Millstone, MA, USA	0/06:25	0:33	52.4	189x128
Arecibo, Puerto Rico	0/08:04	0:47	74.4	189x163
Hobart, Australia	0/22:04	0:47	76.3	207x186
Millstone, MA, USA	1/00:21	0:13	22.0	206x193
Roberval, Canada	1/01:58	0:15	12.5	207x196
Roberval, Canada	1/01:59	0:15	12.5	206x199
Arecibo, Puerto Rico	1/21:40	0:12	20.4	208x206
PDP Release	2/03:50			208x206
PDP Retrieval	2/11:02			208x206
PDP experiment concluded -- Kwajalein Atoll	6/14:02			207x195
Deorbit Burn	6/22:09	0:14	20.3	17x180
Entry Interface	6/22:42	4:09	430.7	
KSC Landing	6/23:12			

SUMMARY OF ORBITER AND SCIENCE ACTIVITIES

Flight Day 1
Ascent
Open payload bay doors
Activate Spacelab systems
Activate payload experiments
Deploy, align and check the Instrument Pointing System (IPS); perform initial solar observations
Fire Shuttle engines in first 3 OMS burns as part of plasma depletion observations
Draw blood for vitamin D metabolite experiment
Maneuver to gravity gradient attitude for superfluid helium experiment operations; when complete, re-orient orbiter for PDP operations

Flight Day 2
Fire Shuttle engines in next 3 OMS burns
Study the space environment with the Plasma Diagnostics Package (PDP) extended on the RMS
Operate PDP and the Vehicle Charging and Potential (VCAP) experiment to investigate plasma activity
Maneuver again to gravity gradient attitude for superfluid helium experiment operations
Select and observe new solar viewing targets
Begin collecting astrophysical data with the X-ray telescope, infrared telescope and cosmic ray detector

Flight Day 3
Release PDP satellite using RMS; maneuver orbiter in a "fly- around" as PDP studies plasma away from the Shuttle; retrieve the satellite with the arm and return it to the vicinity of the payload bay for continued experiments
Operate PDP and VCAP jointly during fly-around
Select and observe new solar targets
Continue astronomical observations

Flight Day 4
Concentrate on solar observations with more than 15 hours of solar studies
Study Shuttle glow with first joint operations of PDP and the infrared telescope (IRT)

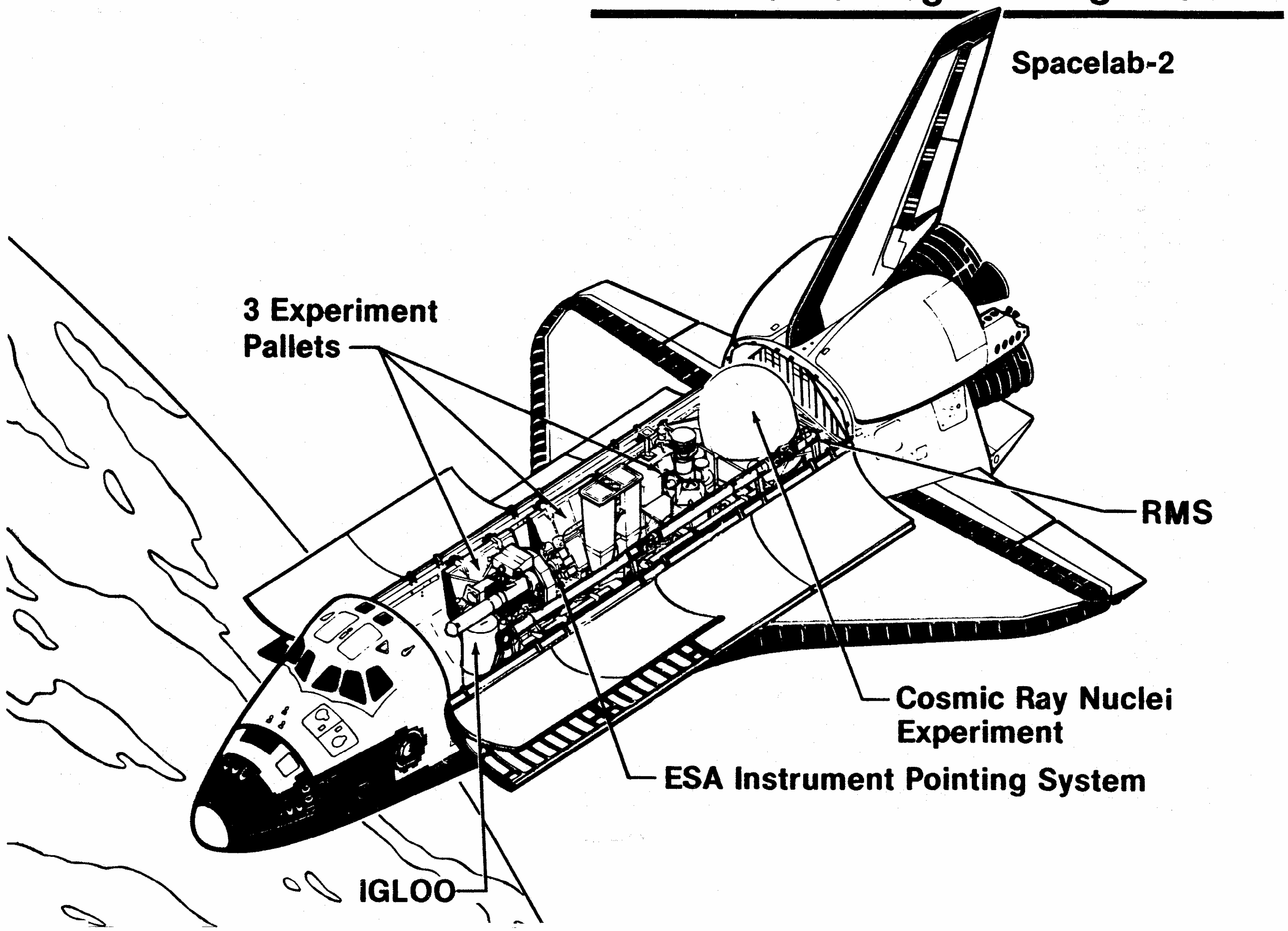
Flight Day 5
Operate PDP and IRT jointly to study Shuttle glow
Continue experiment operations in all disciplines

Flight Day 6
Collect blood for vitamin D metabolite investigation
Sample gas and monitor temperatures in the Plant Growth Unit (PGU)

Flight Day 7
Collect final blood samples
Make final solar observations; stow IPS and prepare for landing Deactivate pallet experiments
Deactivate Spacelab 2 systems
Fire engines in final OMS burn for plasma depletion experiment Close payload bay doors
Deorbit burn
Entry interface
Landing at Edwards AFB, CA, Runway 17

NASA

National STS Program
STS 51-F [24] Cargo Configuration



SPACELAB 2 CONFIGURATION

Spacelab 2 is composed of three pallets holding experiments and one experiment mounted in a support structure at the aft end of the payload bay. The first pallet holds the Instrument Pointing System; on it are experiments in solar physics and atmospheric physics. The igloo holding Spacelab subsystems is attached to the forward end of this pallet. The other two pallets are connected to form a train, containing experiments in atmospheric physics, plasma physics, high-energy astrophysics, infrared astronomy and technology research. The cosmic ray experiment is located on a support structure behind the third pallet. The two life sciences experiments are located in orbiter middeck lockers.

Spacelab 2 Configuration (Forward to Aft):

Igloo (attached by struts to Pallet #1)

Pallet #1:

IPS (Instrument Pointing System)
SOUP (Solar Optical Universal Polarimeter)
CHASE (Coronal Helium Abundance Spacelab Experiment)
HRTS (High Resolution Telescope and Spectrograph)
SUSIM (Solar Ultraviolet Spectral Irradiance Monitor)
VCAP (Vehicle Charging and Potential Experiment) electron generator

Pallet #2:

VCAP (Spherical Probe and Charge and Current Probe)
XRT (X-Ray Telescope)

Pallet #3:

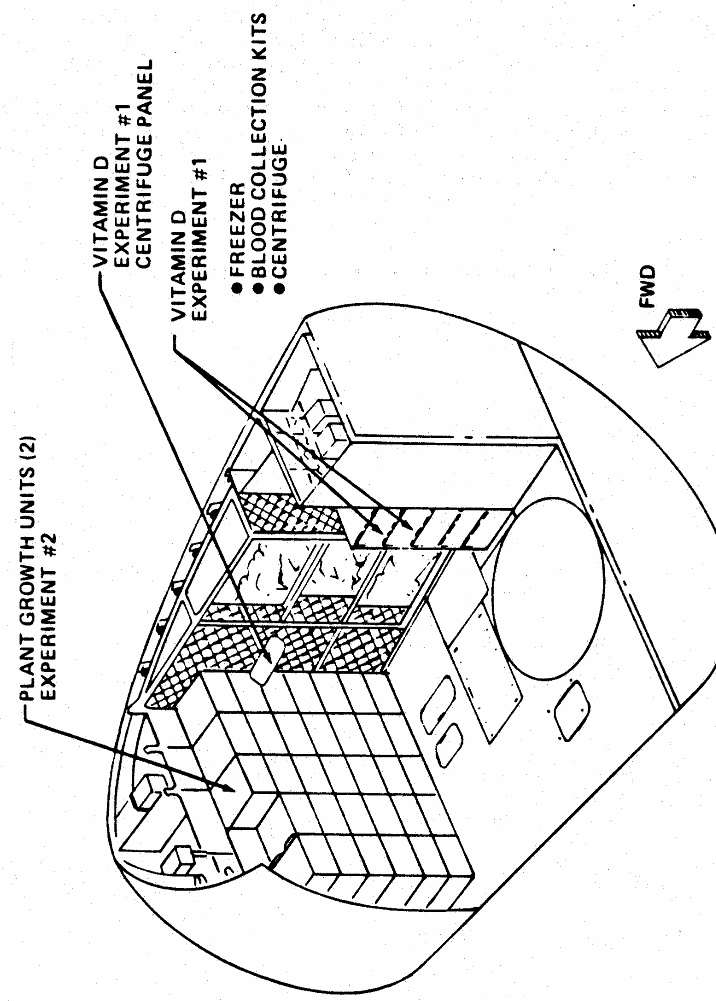
PDP (Plasma Diagnostics Package)
IRT (Infrared Telescope)
SFHE (Superfluid Helium Experiment)

Special Support Structure:

CRN (Cosmic Ray Nuclei experiment)

Shuttle Middeck:

Blood collection kit
PGU (Plant Growth Unit)
Middeck Layout (Plant growth, Vitamin D)


PLANT GROWTH UNITS (2)
EXPERIMENT #2
VITAMIN D
EXPERIMENT #1
CENTRIFUGE PANEL
VITAMIN D
EXPERIMENT #1
• FREEZER
• BLOOD COLLECTION KITS
• CENTRIFUGE
FWD

SPACELAB 2: THE HARDWARE

Pallets

The pallet cross-section is U-shaped providing hard points for mounting heavy experiments and a large panel surface area to accommodate lighter payload elements. Pallet segments are 3 m long and 4 m wide and can be flown independently, or interconnected in a pallet "train." The pallet train cannot consist of more than three segments, whereas the independent configurations may consist of one to five pallet segments. Spaced pallet segments are connected via a utility support structure.

In pallet-only configurations, subsystem equipment necessary for the operation of Spacelab is located in the "igloo," which is mounted on the front frame of the first pallet segment.

Twenty-four inner and 24 outer panels, made of aluminum alloy honeycomb, cover the frame. The inner panels are equipped with threaded inserts so that payload and subsystem equipment can be attached. Each panel can support a uniformly distributed load up to 50 kilograms per square meter.

Twenty-four standard hardpoints made of chromium-plated titanium casting are provided for payloads which exceed the acceptable loading of the inner panels.

Payloads will normally fit within the pallet, but it is possible to carry special payloads which overhang the sides if the necessary arrangement can be made to fix them.

The Igloo -- The Unmanned Service Module for Pallet-Only Spacelab Missions

A main part of the modular Spacelab system is a pressurized automatic supply module, the Igloo, for pallet-only flight configurations. Normally Spacelab subsystem equipment is housed in the core segment of the module. When the module is not being flown, it is, of course, necessary to house the subsystems elsewhere. As the subsystems are designed for a pressurized environment, the Igloo structure has been developed as a pressurized compartment in which Spacelab subsystem equipment can be mounted in a dry air environment at normal earth atmospheric pressure. The Igloo is designed for 7-day missions, but could, if necessary, be used for missions up to 30 days.

The Igloo is always attached vertically to the forward end frame of the first pallet in the pallet-only mode.

The primary structure is a cylindrical, locally stiffened shell, made of aluminum alloy forged rings, and closed at one end. The other end has a mounting flange for the cover. A seal is inserted when the two structures are joined together mechanically to formal a pressure-tight assembly.

Externally the primary structure has fittings for the structure by which it is fastened to the pallet, for handling and transportation on the ground and for thermal control insulation. Two feedthrough plates accommodate utility lines and a pressure relief valve. Internally there are mounting facilities for sub system equipment and the Igloo secondary structure. The weight of an equipped Igloo is approximately 665 kg, and 2.2 cubic meters is available for subsystems.

The cover is also a cylindrical shell, made of welded aluminum and closed at one end. Adapters for the positive relief valve and the burst disc are on top of the cover. The cover can be removed to allow full access to the interior.

Subsystem equipment is mounted on the secondary structure which also acts as a guide for the removal or replacement of the cover. The secondary structure is hinge-fastened to the primary structure allowing access to the bottom of the secondary structure and to equipment mounted within the primary structure.

The Igloo is mounted on the pallet by a cross beam and two adjustable link fittings. A set of Spacelab subsystem equipment, similar to the set integrated in the module, is installed within the Igloo in the pallet-only configuration.

The following equipment (basic and mission dependent) is located in the Igloo:

- Three computers (subsystem, experiment and back-up)
- Two input/output units (subsystem and experiment)
- One mass memory
- Two subsystem Remote Acquisition Units
- Nine interconnecting stations
- One emergency box
- One power control box
- One subsystem power distribution box
- One remote amplifier and advisory box
- One high-rate multiplexer
- Freon cooling loop components

In addition to the Igloo the following major subsystem equipment also is mounted to the front frame of the first pallet segment:

- One subsystem 400 Hz inverter
- One experiment 400 Hz inverter
- Freon cooling loop components

Thermal control of the 400 Hz inverters is also achieved by cold plates connected to the pallet Freon cooling loop.

Instrument Pointing System

The Instrument Pointing System (IPS) is a versatile pointing system for use on the orbiter to provide precision orientation capability to a scientific experiment requiring essentially better pointing accuracy and stability than that provided by the orbiter.

With its three-axis gimbal system it can orient payloads of up to 2,000 kg within an accuracy of 1 arc sec.

The IPS development under ESA contract was completed in 1984.

System Description

The IPS is a Spacelab subsystem taking full advantage of the system resources and services without using any of the payload-dedicated support. Located in a standard Spacelab pallet, it comprises a three-axis gimbal system end-mounted to the payload, the payload clamp assembly to support the payload during ground operations and load-critical flight phases, and the control electronics to provide the full operational flexibility during all mission phases and to execute the pointing control operation via the Spacelab subsystem computer.

The dimensions of the payload are only restricted by the width of the pallet and the available length of the pallet train or cargo bay. Accommodation of different payload dimensions can be performed by variation of the clamp unit locations and by adaptation of the gimbal center or rotation.

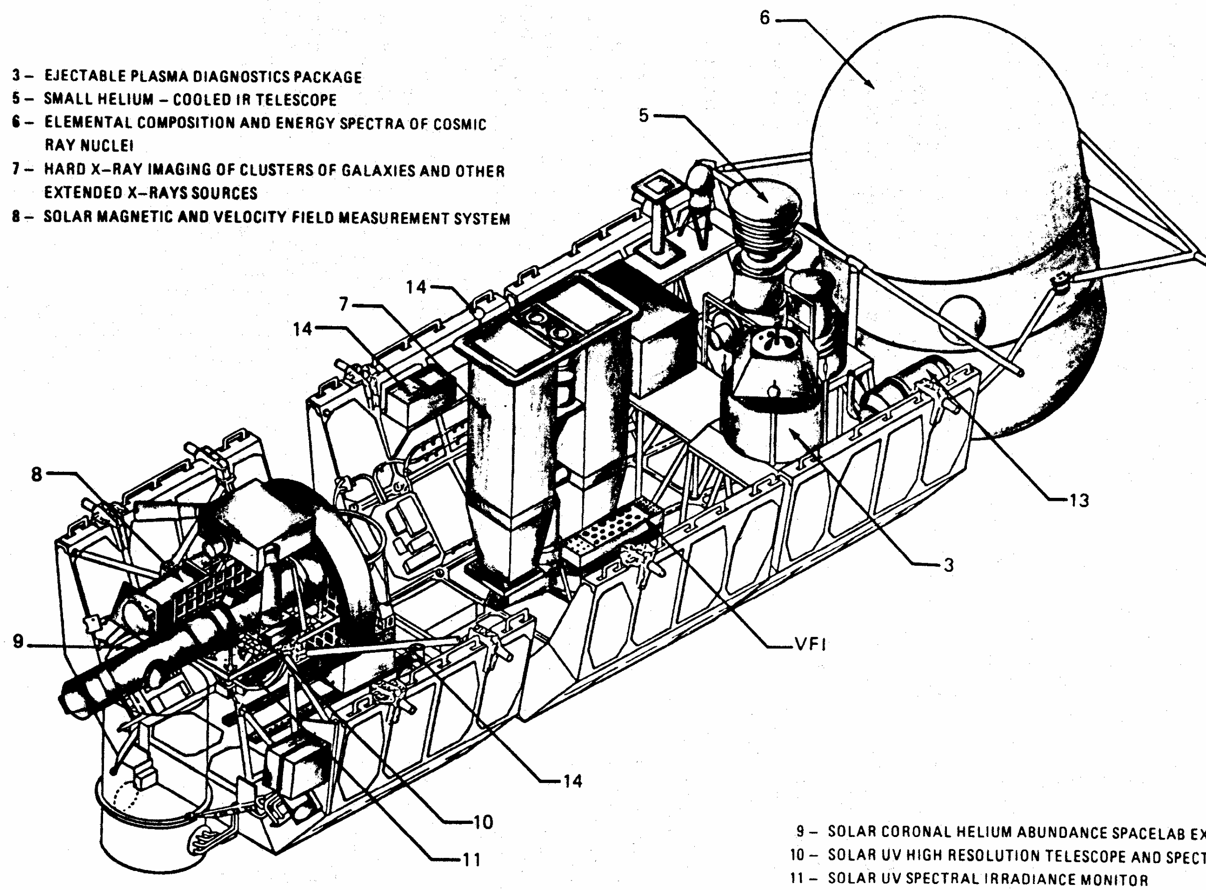
The three identical drive units consist of a shaft supported by precision ball bearings within a titanium housing and controlled by two redundant brushless torque and resolver motors.

The front end of the roll drive unit is connected to the equipment platform, a honeycomb disk of 2 m diameter, which carries subsystems dedicated to electronics and a redundant mechanism which provides, in orbit, the rigid attachment between the payload and the gimbal system (which decouples both during all load generating flight and ground phases).

The IPS is thermally controlled by application of an active heating system on the critical components and a combination of insulated and radiating areas to control the heat exchange to its environment during all critical hot and cold operations. During launch and landing phases the payload will be supported by three attachment flanges with the payload clamp assembly. For on-orbit stowage the payload attachment flanges will be shifted by the pay load gimbal separation mechanism on the equipment platform into three payload clamp units.

SPACELAB MISSION 2

3 – EJECTABLE PLASMA DIAGNOSTICS PACKAGE
5 – SMALL HELIUM – COOLED IR TELESCOPE
6 – ELEMENTAL COMPOSITION AND ENERGY SPECTRA OF COSMIC RAY NUCLEI
7 – HARD X–RAY IMAGING OF CLUSTERS OF GALAXIES AND OTHER EXTENDED X–RAYS SOURCES
8 – SOLAR MAGNETIC AND VELOCITY FIELD MEASUREMENT SYSTEM



9 – SOLAR CORONAL HELIUM ABUNDANCE SPACELAB EXPERIMENT
10 – SOLAR UV HIGH RESOLUTION TELESCOPE AND SPECTROGRAPH
11 – SOLAR UV SPECTRAL IRRADIANCE MONITOR
13 – PROPERTIES OF SUPERFLUID HELIUM IN ZERO–G
14 – VEHICLE CHARGING AND POTENTIAL
VFI – VERIFICATION FLIGHT INSTRUMENTATION

VERIFICATION FLIGHT TESTS

The primary objective of the Spacelab 2 mission is to test Spacelab systems and subsystems. The Spacelab Verification Flight Test (VFT) Program was developed by the Marshall Space Flight Center and will be implemented by the Johnson Space Center.

The first verification tests were performed during the Spacelab 1 mission in 1983, and the systems performed exceptionally well. While Spacelab 1 consisted of a habitable module and one pallet, Spacelab 2 uses a new configuration made up of an igloo, three pallets, the Instrument Pointing System and a special sup port structure. The verification program carried out on 51-F/ Spacelab 2 is designed to test the performance capabilities of these new components and to verify the compatibility of Spacelab with the orbiter and the scientific payload.

A set of special equipment, called Verification Flight Instrumentation (VFI), along with standard orbiter and Spacelab operational instruments, is used to gather data on Spacelab's performance during the mission. VFI sensors situated on Spacelab pallets and in the orbiter provide information on how well Space lab itself responds to the demands of flight. Special tests involving the Spacelab subsystems and one experiment are conducted during the flight. Additional data are gleaned as the ambitious schedule of experiment operations is completed.

The following is a description by category of the specific VFT objectives for 51-F/Spacelab 2:

Environmental Control Subsystem -- Tests are conducted to verify that the passive thermal control subsystem maintains the Spacelab structural elements within specified temperature limits, meets the specified heat leak requirements and, in conjunction with the active thermal control system, meets specified equipment temperature limits. Additional tests are conducted to verify that the active thermal control subsystem is capable of controlling the igloo atmosphere and equipment temperatures.

Structures Subsystem -- Spacelab structures are monitored during ascent, on-orbit operations, descent and landing. To verify load criteria, sensors monitor the response of the pallets and igloo to low frequency vibration during ascent and descent. These sensors also gather data to verify Spacelab's random vibration and acoustic design and test criteria during ascent; the data also define mission load levels to verify mathematical models and predict service life. These tests also will prove that the system used to attach Spacelab to the orbiter is reacting to loads as predicted.

Command and Data Management Subsystem -- Tests are designed to demonstrate the satisfactory integrated operation and performance of the Command and Data Management Subsystem (CDMS) and associated equipment and software in an orbital flight environment. The communications link between Spacelab and the Tracking and Data Relay Satellite System (TDRSS) is checked as a function of the mission operations. The performance of all operating displays and controls, including the effect of all interior lighting and any sunlight/shadow effects, is also tracked.

Environment -- Tests have been designed to compare the radiation environment actually experienced to the specified and predicted levels of radiation; to determine if the radiation protection offered in the film storage areas is adequate; and to provide data on radiation components for which no predictive calculations are available and which are likely to be significant for Spacelab users.

Electrical Power Distribution Subsystem -- This aspect of the VFT is designed to verify the Electrical Power Distribution Sub system performance characteristics by operating all power distribution, conditioning and conversion devices at minimum and maximum mission achievable load levels.

Instrument Pointing System (IPS) -- In conjunction with Experiment #8, which makes solar measurements in visible light, the IPS is tested. During the verification run, the IPS undergoes activation, target acquisition, stability and disturbance effects, free drift tracking, scanning performance, manual pointing control, response to experiment commands, contingency stowage, normal stowage and deactivation. All the tests except for the stowage and deactivation must be completed before the IPS-mounted experiments can begin full operations.

Materials -- Tests are conducted to verify the compatibility of Spacelab exterior materials with the space environment.

AFT FLIGHT DECK

On the two previous Spacelab missions, the crew worked primarily in the habitable module. For Spacelab 2, the payload crew operates experiments from the aft flight deck, a small work area directly behind the cockpit.

The aft flight deck of Challenger for the Spacelab 2 mission is essentially the same configuration as has been flown on previous Space Shuttle missions, with certain modifications for this particular flight.

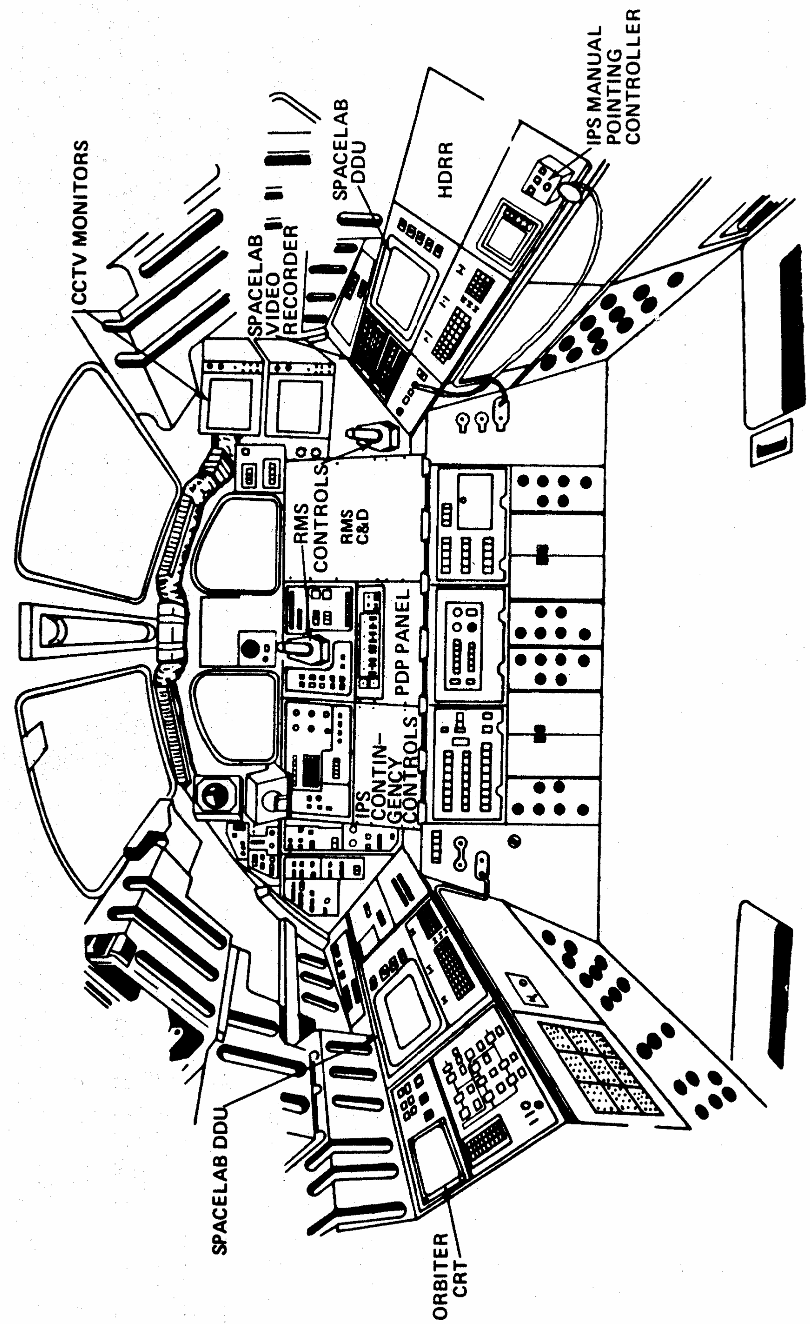
For Spacelab 2, a back-up high data rate recorder has been added -- this one on the port side of the aft flight deck -- as well as a switch panel which provides necessary functions to operate the Ejectable Plasma Diagnostics Package.

A further Spacelab 2 configuration is a contingency jettison panel for the Instrument Pointing System.

Facing the aft flight deck, a crew member aboard the Spacelab 2 mission will find, starting at left, a data display unit, some standard maneuvering switches, then the IPS contingency panel near the center of the console. To the right of that are switches to operate the Remote Manipulator System, then the PDP switch panel, and the second data display unit and the high data rate recorder on the far right.

The starboard-side data display unit (DDU) is used by the mission specialist on duty; the port-side DDU, by the payload specialist.

AFT FLIGHT DECK



MISSION STATISTICS SUMMARY

Payload and Vehicle Weights

	Pounds
Basic Spacelab at Launch	6,443
IPS at Launch	2,971
Mission Dependent Equipment	695
High Data Rate Recorder	646
Verification Flight Instrumentation	1,528
Spacelab Experiments at Launch	12,264
Mission Peculiar Equipment	2,616
Orbiter Equipment Required by Spacelab	5,982
Total Spacelab 2 Payload	33,145
Total Payload Bay and Middeck Summary	33,263
Orbiter Plus Cargo at Liftoff	252,855
Total Vehicle at Liftoff	4,514,504
Landing Weight	216,900

Spacelab Pallet Dimensions

Length: 10 ft
Width: 13 ft.

Computer Storage and Data Handling

Experiment Computer Memory: 64,000 or 64k (16 bit words) Central Processing Unit (CPU): 320,000 or 320k instructions/sec
Data Handling Orbit/TDRSS: Up to 50 megabits/second
Onboard Storage Capacity: Up to 32 megabits/second

Spacelab 2 Resource Status

	Available	Required	Margin
Crew Time (hours)	423	279	+144
Electrical (kilowatt hours)	1,150	916	+234

PRE-LAUNCH PREPARATIONS

Spacelab was designed, developed, funded and built by the European Space Agency (ESA) as Europe's contribution to America's Space Transportation System. Considered one of ESA's most important programs, Spacelab represents a European investment of almost $1 billion. Nine ESA member states -- Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Switzerland, the United Kingdom and one state with associate member status, Austria -- participated in the endeavor. Beginning with the decade of development leading to Spacelab's first flight in 1983 and continuing today in preparation for future missions, NASA and ESA work cooperatively to ensure that Spacelab is utilized successfully as an integral component of the Space Transportation System.

Preparations for the Spacelab 2 launch began in 1982, when ESA delivered the three pallets to the Kennedy Space Center Operations and Checkout Building. These pallets are being used for the first time during the Spacelab 2 mission, but similar pallets have been tested and used successfully to perform science on previous Shuttle missions. In 1983 the pallets were equipped with special support equipment needed for the attachment of Spacelab 2 instruments. As scientific instruments arrived at the Kennedy Center, they were tested and mounted on the three pallets. The Igloo, which contains Spacelab subsystems for data collection, instrument commanding and thermal control, was also attached to the first pallet. The cosmic ray experiment was fixed inside a special support structure, located in the aft end of the payload bay.

In the fall of 1984, after undergoing many tests in Europe, the Instrument Pointing System arrived at the Kennedy Space Center. Three solar instruments and one atmospheric instrument were mounted on the pointing system, which was subsequently mounted on the first pallet.

Initial integration activities were completed in the spring of 1985 with the successful completion of Mission Sequence Testing designed to verify the compatibility of experiments with each other and with simulated Spacelab support subsystems. These tests culminated in May of 1985 in the Closed Loop Test in which all commandable Spacelab experiments were operated briefly by remote control from the Payload Operations Control Center (POCC) at Johnson. The crew and scientists who developed Spacelab 2 experiments were active participants in integration and testing. Shortly after the completion of the Closed Loop Test, the Spacelab and integrated payload was placed in the Cargo Integration Test Equipment (CITE) stand to verify that it was compatible with the Shuttle. The CITE duplicates the mechanical and electronic systems of the orbiter.

On June 8, 1985, the Spacelab and integrated payload was transferred to the Orbiter Processing Facility (OPF) and in stalled in the payload bay of the orbiter Challenger.

On June 12, a Spacelab-Orbiter interface test was performed to check all Shuttle and Spacelab connections. The next day, some Spacelab 2 experiments were operated again by remote control from the POCC during an end-to-end test. Commands initiated at JSC consoles were processed through the POCC and Mission Control Center computers en route to Spacelab inside the Challenger at Kennedy. This test was similar to the Closed Loop Test, except TDRSS and Challenger were included in the loop and a high rate data mode was used.

Launch Window

The launch window for the 51-F/Spacelab 2 mission opens July 12, 1985, at 4:30 p.m. EDT, for 2 hours, closing at 6:30 p.m. EDT. The window was calculated to satisfy the lighting conditions for particular plasma and astronomical experiments. The launch window opens at the same time for the next 5 to 6 days. After that, the moon conditions, which affect several of the astronomical and plasma observations, become unfavorable. The optimum launch time is 4 to 5 days before a new moon, when the night sky is darkest, but a launch can occur a few days beyond that without seriously affecting investigations.

LANDING AND POST-LANDING OPERATIONS

Kennedy Space Center is responsible for ground operations of the orbiter once it has rolled to a stop on the runway at Edwards Air Force Base and for preparing the Challenger/Spacelab for return to Kennedy Space Center. After landing, the flight crew begins "safing" vehicle systems. Immediately after wheel stop, specially garbed technicians will first determine that any residual hazardous vapors are below significant levels in order for other safing operations to proceed.

Once the initial safety assessment is made, access vehicles are positioned around the rear of the orbiter so that lines from the ground purge and cooling vehicles can be connected to the umbilical panels on the aft end of Challenger. Freon line connections are completed and coolant begins circulating through the umbilicals to aid in heat rejection and protect the orbiter's electronic equipment.

Other lines provide cooled, humidified air to the cargo bay and other cavities to remove any residual fumes and provide a safe environment inside Challenger.

A mobile white room is moved into place around the crew hatch once it is verified that there are no concentrations of toxic gases around the forward part of the vehicle. The crew is expected to leave Challenger about 30 to 40 minutes after landing. As the crew exits, technicians enter the orbiter to complete the vehicle safing activity.

Postlanding operations associated with the Spacelab 2 payload include removal of certain time-critical items, such as plants, blood samples, film and tape recordings, 1 hour after landing. These items are given to representatives of the investigator teams at the landing site.

A tow tractor is connected to Challenger and the vehicle is pulled off the runway at Edwards and positioned inside the Mate/Demate Device. After the Shuttle has been jacked and leveled in the mate/demate workstands, residual fuel cell cryogenics are drained and unused pyrotechnic devices are disconnected prior to the return of the orbiter to Kennedy.

The aerodynamic tail cone is installed over the three main engines, and the orbiter is bolted on top of the 747 Shuttle carrier aircraft for the ferry flight back to Florida. The 747 is scheduled to leave California about six days after landing. An overnight stop is scheduled for refueling, and the ferry flight continues the next day.

Once back at Kennedy, removal and deintegration of Spacelab 2 proceeds in nearly reverse order of assembly, but without the elaborate testing stages. In most cases, disassembly is only a temporary state for Spacelab, as much of the hardware is immediately taken to checkout areas for use on upcoming missions.

SPACELAB 2 INVESTIGATIONS

Spacelab 2 is a multi-disciplinary mission with 13 investigations in seven scientific disciplines: solar physics, atmospheric physics, plasma physics, high energy astrophysics, infrared astronomy, technology research and life sciences. Eleven of the investigations were developed by U.S. scientists and two by scientists from the United Kingdom.

Spacelab 2 investigations were selected by a peer review process on the basis of their intrinsic scientific merit and suitability for flight on the Shuttle. Proposals for experiments came through several channels, including NASA announcements of opportunity that solicited research ideas from the worldwide scientific community.

The principal investigators for each experiment then formed an Investigator Working Group (IWG). Chaired by the Spacelab 2 mission scientist, Dr. Eugene Urban of Marshall Space Flight Center, this group participated in mission planning.

In addition, they selected and helped train the four Spacelab 2 payload specialists and then recommended two to perform their experiments in space.

A brief synopsis of each experiment follows, including the title of each investigation and the name and affiliation of each principal investigator. More detailed information on each experiment is contained in the publication "Spacelab 2" (Pub. #20M385) available at all NASA news centers.

Solar Physics

Three of the mission's experiments make solar observations in visible and ultraviolet light. Above the atmosphere, the instruments see solar emissions that are undetectable from the ground. Mounted together on the Instrument Pointing System, these instruments provide data to make a composite image of the sun's magnetic, structural and gaseous elements. During the mission, the crew and ground investigators are able to select areas of solar activity as viewing targets.

Solar Magnetic and Velocity Field Measurement System/Solar Optical Universal Polarimeter (SOUP) -- Dr. Alan M. Title, Lockheed Solar Observatory, Palo Alto, CA. An instrument complement of telescope and video cameras observes the sun's magnetic field activity in different wavelengths and polarizations in visible light. Coronal Helium Abundance Spacelab Experiment (CHASE) -- Dr. Alan H. Gabriel, Rutherford Appleton Laboratory, Chilton, United Kingdom, and Prof. J. Leonard Culhane, Mullard Space Science Laboratory, University College, London, United Kingdom. A telescope and spectrometer are used to detect hydrogen and helium emission lines in order to assess solar hydrogen and helium abundance.

Coronal Helium Abundance Spacelab Experiment (CHASE) – Dr. Alan H. Gabriel, Rutherford Appleton laboratory, Chilton, United Kingdom, and Prof. J. Leonard Culhane, Mullard Space Science laboratory, University College, London, United Kingdom. A telescope and spectrometer are used to detect hydrogen and helium emission lines in order to assess solar hydrogen and helium abundance.

Solar Ultraviolet High Resolution Telescope and Spectrograph (HRTS) -- Dr. Guenter Brueckner, Naval Research Laboratory, Washington, DC. This telescope and spectrograph system observes solar radiation from the sun's outer layers and records the data on film and video.

Atmospheric Physics

The atmospheric physics experiment, closely related to the Spacelab 2 solar investigations, measures solar ultraviolet radiation in the upper atmosphere. The instrument is scheduled to fly on several Spacelab missions so that long-term variations in solar ultraviolet radiation can be identified.

Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) -- Dr. Guenter Brueckner, Naval Research Laboratory, Washington, DC. An instrument complement of spectrometers and detectors is tuned to a narrow range of ultraviolet radiation and operates automatically every time the IPS is turned toward the sun. Self-check calibration systems monitor the instruments and ensure accurate measurements. This instrument made a checkout flight on the third Shuttle mission.

Plasma Physics

The three Spacelab 2 plasma physics experiments investigate processes in the ionosphere, the upper atmospheric region in which the Shuttle-Spacelab travels. The ionosphere is affected by the electrified gas or plasma that streams continuously from the sun. This mission's investigations study the plasma environment with a free-flying satellite filled with sensors, by artificially stimulating the plasma with electrons and with ground observatories that can monitor the spacecraft's effect on the atmosphere.

Ejectable Plasma Diagnostics Package (PDP) – Dr. Louis A. Frank, University of Iowa, Iowa City. The instrument package, flown previously on the third Shuttle mission, is extended and released by the Remote Manipulator System (RMS) to make measurements after the orbiter has maneuvered to selected attitudes. On the third flight day after about seven hours of operation as a free-flyer, the PDP is recaptured by the manipulator arm and returned to the vicinity of the payload bay. Before landing, it is locked back in place on the aft pallet, unless an anomalous situation forces the PDP to be left behind in orbit.

Vehicle Charging and Potential Experiment (VCAP) -- Dr. Peter M. Banks, Stanford University, Stanford, CA. An electron generator emits a stream of electrons, and the effects of the emissions on the plasma environment are recorded by three plasma probes. Some VCAP experiments work with the PDP as the satellite is moved through the generated electron beam. A special television camera films the electron beam. This experiment operated during the third Shuttle mission.

Plasma Depletion Experiments for Ionospheric and Radio Astronomical Studies -- Dr. Paul A. Bernhardt, Los Alamos National Laboratory, Los Alamos, NM, and Dr. Michael Mendillo, Boston University, Cambridge, Mass. The effects of Shuttle thruster firings on the ionosphere are measured from five radio observatories on the ground. The firings trigger chemical reactions that create ionospheric "holes"; the observatories will study the changed plasma state and transmission qualities of these altered upper atmospheric regions.

High Energy Astrophysics

High energy radiation, in the forms of X-Ray and gamma-ray radiation and charged particles called cosmic rays, cannot be observed from Earth. Above the atmosphere, Spacelab 2 carries two large, sensitive high-energy radiation detectors.

Elemental Composition and Energy Spectra of Cosmic Ray Nuclei Between 50 GeV/Nucleon and Several TeV/Nucleon -- Drs. Peter Meyer and Dietrich Muller, University of Chicago. The cosmic ray detector, on a special support structure at the end of the pallet train, is exposed to space throughout the mission. Particles entering the detector are counted and identified automatically, and the data are transmitted to the ground.

Hard X-Ray Imaging of Clusters of Galaxies and Other Extended X-Ray Sources/X-Ray Telescope (XRT) -- Dr. A. Peter Willmore, University of Birmingham, England. Two telescopes, observing at different resolutions, detect distant and intense regions of X-Ray emission to create X-Ray images of remote clusters of galaxies and some other interesting X-Ray sources. A microprocessor system controls target selection and pointing.

Infrared Astronomy

Infrared radiation, emitted by almost every celestial object, is best observed outside the atmosphere, where Earth's background radiation is eliminated. A Spacelab 2 telescope complements observations made recently by the Infrared Astronomy Satellite (IRAS).

A Small Helium-Cooled Infrared Telescope (IRT) -- Giovanni G. Fazio, Smithsonian Astrophysical Observatory, Cambridge, Mass. The telescope measures infrared radiation from a variety of sources. It can be controlled from the ground or from Spacelab computers.

Technology Research

Spacelab 2, with its delicate observational instruments, provides a chance to test advanced cooling systems. Extremely low temperatures allow telescopes to detect celestial radiation without the interference of background emissions from the instruments themselves.

In addition to an experiment dedicated to studying the characteristics of superfluid helium, the Spacelab 2 infrared telescope uses superfluid helium as its cryogen.

Properties of Superfluid Helium in Zero-Gravity -- Dr. Peter V. Mason, Jet Propulsion Laboratory, Pasadena, CA. On Spacelab 2, superfluid helium (helium cooled almost to absolute zero) is tested for its efficiency as a cryogen.

An insulated container, or dewar, attached to the third pallet contains 2 fluid physics experiments that operate while the Shuttle is in a gravity gradient (tail down) attitude. Sensors inside the dewar monitor the superfluid helium throughout the entire mission.

Life Sciences

The two Spacelab 2 life science investigations examine human and plant biological processes in the space environment. One investigation studies biochemical agents in human blood during space flight. The other is a variation of a plant growth experiment previously flown on the third Shuttle mission.

Vitamin D Metabolites and Bone Demineralization -- Dr. Heinrich K. Schnoes, University of Wisconsin, Madison. This investigation studies the link between bone mineral loss during space flight and the activity of vitamin D in the human body. Blood samples are taken from crew members during flight, stored until landing and then compared to samples taken from the crew before flight.

Gravity-Influenced Lignification in Higher Plants/Plant Growth Unit (PGU) -- Dr. Joe R. Cowles, University of Houston. Mung beans and pine seedlings, planted in the Plant Growth Unit before flight, are flown to monitor the production of lignin, a structural rigidity tissue found in plants. The crew checks temperatures daily, and takes gas samples and photographs twice during the mission.

ADDITIONAL EXPERIMENTS

Protein Crystal Growth Experiment

The experiment, Protein Crystal Growth in a Microgravity Environment, was sent into orbit during Shuttle Mission 51-D. During this current flight, it again uses the stability of low gravity to produce more nearly perfect crystals in space. Scientists have predicted that these crystals can be grown many times larger in space. When grown on Earth, these crystals are so small that scientists cannot analyze the molecular structure of the crystals. On this test flight, the experiment operates automatically with limited crew intervention.

Two crystal growth units are stored inside a middeck locker. Dr. Charles E. Bugg of the University of Alabama in Birmingham is the principal investigator for the experiment; he is assisted by co-investigators at the University of Alabama in Huntsville and the Marshall Space Flight Center.

Shuttle Amateur Radio Experiment

The American Radio Relay League (ARRL) and Radio Amateur Satellite Corp. (AMSAT) will begin a Shuttle Amateur Radio Experiment (SAREX) this mission with "ham" radio and TV operators on Earth. The radio and TV experiment is sponsored by NASA.

Two of NASA's onboard astronaut amateur radio operators, Anthony England, mission specialist, and John-David Bartoe, payload specialist, will converse from Challenger with hams through a handheld radio. Gordon Fullerton, spacecraft commander, is a former amateur radio operator and also may take the microphone.

Local ham clubs nationwide are inviting youth groups -- including students participating in the Young Astronaut Program -- to hear, see and communicate with the Challenger ham station. Ham radio communications also are expected with amateurs in England, Israel, Australia and Japan.

One part of the SAREX experiment is to involve youth interested in science and technology in the Space Shuttle Program. Rather than spend the limited SAREX time talking randomly to amateurs on the ground, astronauts will talk to clubs with dedicated frequencies for 1 or 2 minutes.

Astronaut England hopes the transmissions will encourage young people to demonstrate that there is a lot of fun in science and technology and also give them a little bit of first hand experience with the Shuttle operation.

First operation of a ham radio from space was by astronaut Owen Garriott through a portable 2-m transceiver from Columbia on STS-9.

For the first time, amateur television will be part of a space flight when slow-scan TV is sent in black and white, followed by compatible color from Challenger. A 15 word-per-minute Morse code identification with England's call sign will be sent by an automatic device.

The radio and TV hardware, stored in the orbiter crew compartment, comprises a slow scan television converter and a 2-m band handheld transceiver flown on STS-9. The TV and transceiver's modes permit conversion of Shuttle video to slow-scan TV and transmission on the 2-m amateur band through a window-mounted antenna. Another mode allows transmission of TV from a handheld camera (part of SAREX).

Shuttle-to-Earth transmissions are in the 2-m amateur band and use frequency modulation (FM). Orbit numbers and ground tracks for SAREX operations will be announced before flight by ARRL.

Slow-scan TV signals transmitted from ham stations on Earth may be received by the astronauts on Challenger using the window mounted antenna and the 2-m transceiver. The signals are stored in the scan converter and displayed on a 2-inch color monitor.

Mission 51-F air-to-ground communications will be retransmitted by employee amateur radio clubs at Greenbelt, Md.; Pasadena, CA; Mountain View, CA; Huntsville, AL; Great Britain; Houston and on several frequencies which can be monitored with typical amateur and short wave receivers.

Club locations and retransmit frequencies are (MHz):

Goddard Space Flight Center, Greenbelt, MD	3.860	7.185	14.295	21.390	SSB
				147.450	FM
Jet Propulsion Laboratory, Pasadena, CA	224.040	145.460			FM
Ames Research Center, Mountain View, CA	145.580				FM
	7.270				SSB
Marshall Space Flight Center, Huntsville, AL	145.430				FM
Radio Society of Great Britain	3.650	7.047			SSB
	145.525				FM
Johnson Space Center, Houston TX	146.640				FM

Note: The American Radio Relay League Public Information Officer is Paul Courson, who may be reached at the Johnson Space Center (phone (713) 280-8341 or 280-8342).

Plant Carry-On Container

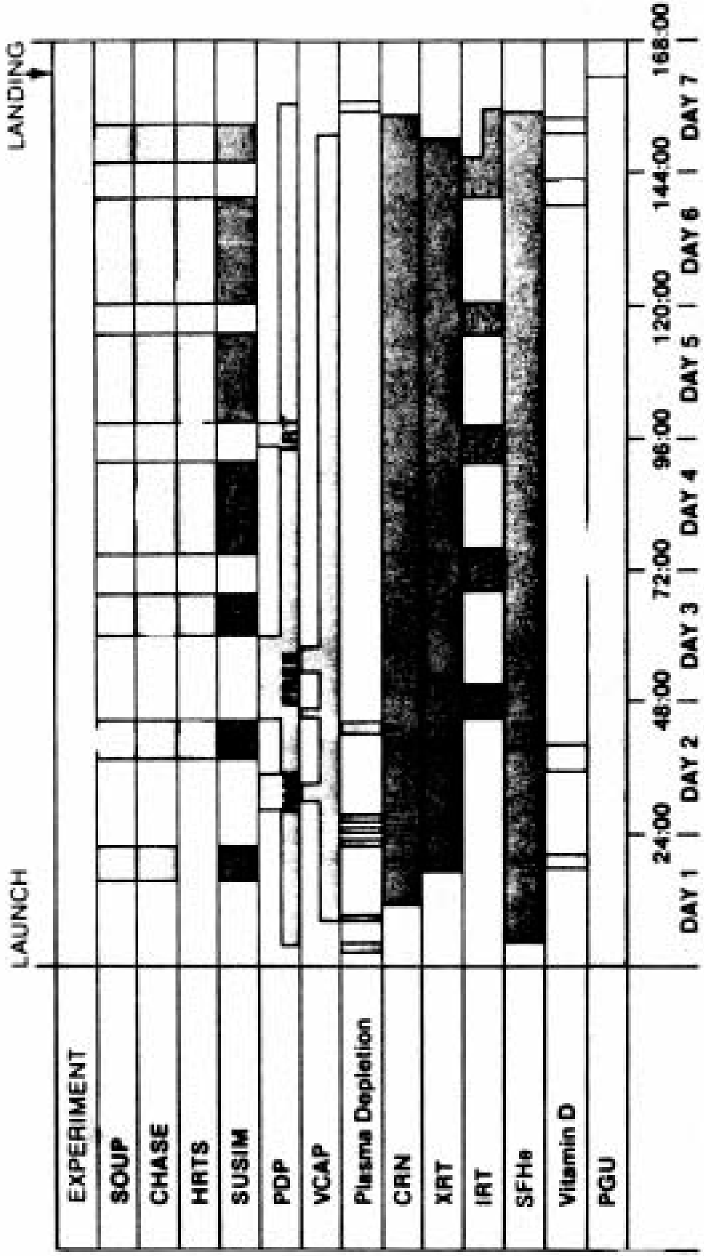
A Plant Carry-On Container (PCOC), located in a middeck locker, aboard flight 51-F will provide the means for a unique study of gravitropism by a group of select students who are considering the space sciences as a career option. The students also will focus on the development of a diet and delivery system that can provide purified diets in a non-contaminating process.

Pre- and post-flight efforts of the group will delve into the physiology of the vestibular system and how the visual and vestibular systems interact to allow perception of body orientation and motion in a spatial environment.

Twenty-four students presently are involved in the program that, in support of agency policy, has strong minority involvement. Over a 6-week period, college level students participate in the "life cycle" of an experiment. The program emphasizes hands-on experience.

The pilot program, in which college level credit is given, is supported by Kennedy Space Center, the University of Central Florida and Florida A and M University. The program manager is Marvin Christiansen, NASA Headquarters.

"SCIENCE TIMELINE"



PAYLOAD SPECIALISTS

Payload specialists are NASA's newest breed of workers in space. The first payload specialists made their debut during the Spacelab 1 mission in 1983. Since then, payload specialists have flown on other Shuttle missions.

Payload specialists are career scientists and engineers who are identified and selected by their peers to fly into space and conduct experiments. After the mission, they return to their previous position at the institution sponsoring their research. Usually, they are intimately connected with the mission and are the principal investigator or co-investigator for one or more of the mission's experiments.

The Spacelab 2 Investigator Working Group, consisting of the principal investigators for all the experiments, nominated and selected four payload specialist candidates. The principal investigators helped train the candidates in their laboratories and later named the flight and alternate payload specialists.

The working group selected Dr. Loren Acton, a solar physicist at the Space Sciences Laboratory of the Lockheed Palo Alto Research Laboratory, and Dr. John-David Bartoe, an astrophysicist at the Naval Research Laboratory, to fly as payload specialists for the Spacelab 2 mission. They also named two other payload specialists, Dr. Dianne Prinz, a research physicist at the Naval Research Laboratory, and Dr. George Simon, a solar physicist at the Air Force Geophysics Laboratory, as alternate payload specialists. Prinz and Simon will serve as flight backups and as members of the mission support team responsible for controlling and directing experiment operations from the Payload Operations Control Center at the Johnson Space Center in Houston.

All four Spacelab 2 payload specialist candidates underwent two basic types of training: mission dependent and mission independent.

MISSION DEPENDENT TRAINING is associated with Spacelab 2 experiments and payload operations. Since the payload specialists' main duty is to operate experiments, this is the longest part of the training program.

Spacelab 2 scientists can communicate with the crew via voice and text links and they can send automated commands directly to the onboard computer to control their experiments.

The capabilities of the POCC include some data processing. Multiplexed Spacelab 2 data are received at up to 48 megabits per second and converted into separate channels. These channels are routed to recorders, to the experimenters' ground support equipment, or to experiment consoles for display.

Much of this training was provided by the individual Spacelab 2 principal investigators in their own laboratories. Marshall Space Flight Center provided training in integrated payload operations at the Payload Crew Training Complex inside a high-fidelity mockup of the aft flight deck configured for Spacelab 2. The crew also became familiar with actual flight hardware during integration tests at the Kennedy Space Center.

POCC POSITIONS

The following is a general description of the cadre personnel working in the Spacelab POCC front room at Johnson Space Center.

POD (Payload Operations Director) -- is the senior member of the mission manager's cadre team in the POCC; oversees Spacelab 2 mission operations and directs the payload operations team and science crew.

MSCI (Mission Scientist) -- represents scientists with experiments on the flight and interfaces with the mission manager and the POD with respect to mission science operations and accomplishments.

CIC (Crew Interface Coordinator) -- manages POCC use of air-to-ground voice loop and serves as a focal point for communications with payload crew; enables and coordinates principal investigator communication with payload crew.

APS (Alternate Payload Specialist) -- assists the payload operations team and payload crew in devising solutions to problems, troubleshooting and changing crew procedures when necessary; advises the mission scientist of possible impacts or problems and assists the CIC in direct voice contact with the payload crew.

OC (Operations Controller) -- coordinates the activities of the payload operations team to efficiently accomplish POCC functions required to support the real-time execution of the approved mission timeline; assesses proposed crew timeline alteration and coordinates the implementation of approved actions with the POCC cadre positions.

MUM (Mass Memory Unit Manager) -- initiates experiment command uplinks to the Spacelab after receiving data set changes from the POCC operations team.

MISSION INDEPENDENT TRAINING is associated with learning the fundamental skills necessary to live and work safely aboard the Shuttle-Spacelab. Johnson Space Center provided familiarization with living conditions as well as medical, emergency and survival training. Kennedy Space Center provides launch and landing site training.

MISSION SUPPORT

Payload Operations Control Center

The Payload Operations Control Center (POCC), located in Building 30 at Johnson Space Center, is the command post for the management of Spacelab 2 scientific payload activities during the mission. The POCC is similar to the Mission Control Center (MCC), which has overall responsibility for the flight and operation of the orbiter. POCC and MCC personnel coordinate their efforts to ensure a successful mission.

Members of the Marshall mission management team and principal investigators with their research teams work in the POCC in either three 8-hour shifts or two 12-hour shifts. Using POCC equipment, they monitor, control and direct experiment operations aboard Spacelab.

The POCC, covering an area of more than 4,000 square feet, is situated adjacent to the flight control room on the second floor of the MCC. It is composed of a payload control room, a mission planning room, six user rooms and a customer support room. The payload control room or "front room" houses part of the mission management team who track the overall science mission. Other members of the mission management team support operations from the "back room."

Individual experiment teams have work areas in the user rooms. Each user room contains three work stations, each having a computer terminal, keyboard, CRT display, floppy disk unit and hard copy unit for the users' own payload monitoring and control. In addition, science teams may set up their own experiment equipment.

Command and data links between the POCC and Spacelab enable scientists to follow the progress of their experiments, assess and respond to real-time information and be actively involved in the investigative process.

PAYCOM (Payload Command Controller) -- configures the POCC for ground command operation and controls the flow of experiment commands from the POCC as required; troubleshoots any problems in the rejection of those commands. Advises OC on command systems status.

PAP (Payload Activity Planner) -- directs the mission replanning activity by receiving proposed changes to the mission timeline and coordinating them with the POCC operations team; assesses proposed changes to the current timeline and advises the POD of potential impacts to the timeline.

DMC (Data Management Coordinator) -- is responsible for maintaining and coordinating the flow of payload data to and within the POCC for the cadre and principal investigators; assesses proposed real-time changes to the experiment timeline and payload data requirements which affect the payload downlink data.

TVOPS (TV Operations Controller) -- serves as the focus within the POCC for Spacelab payload inflight television and photographic operations, specifically with regard to scene development of flight crew activities.

PAO (Public Affairs Officer) -- provides Spacelab 2 mission commentary and serves as the main source for Spacelab payload information.

SPACELAB 2 SHIFT OPERATIONS

12-hour shifts	**Blue**	**Red**
Payload Crew	MS3 (England)	MS1 (Henize)
	PS2 (Bartoe)	PS1 (Acton)
Orbiter Crew	MS2 (Musgrave)	PLT (Bridges)

CDR (Fullerton) will work during both shifts as needed

Payload Operations Control Center Cadre Positions
Johnson Space Center (JSC)

Mission Manager: Roy C. Lester
Assistant Mission Manager: Hubert R. Gangl Jr.; supports the mission from the Huntsville Operations Support Center (HOSC) at Marshall.

Mission Scientist	Dr. Eugene W. Urban	Stuart Clifton	
MSCI	Charles Sisk	Robert Wilson	
POD	Tom Rankin	Axel Roth	
APS	George Simon	Dianne Prinz	
CIC (3 shifts)	Joe Hale	Barbara Cobb	Bill Bock
OC	Ray Eady	Fred Applegate	
DMC	Jack Bullman	Darrell Bailey	
PAP	Scott Perrine	Gordon Wood	
MUM	Morayma Luis	Mike Purvey	
TV OPS	Rip Koken	John Harrison	

Mission Control Center
(3 teams working 9-hour shifts)

Orbit Team 1 Flight Director	G. A. Pennington
Orbit Team 2 Flight Director	John Cox (Lead flight director)
Orbit Team 3 Flight Director	Lee Briscoe
Ascent/Entry Flight Director	T. Cleon Lacefield

Spacelab 2 Management

Program Manager	Louis J. Demas	NASA Headquarters
Program Scientist	Daniel Spicer	NASA Headquarters
Spacelab Program Manager	John W. Thomas	Marshall Space Flight Center
Mission Manager	Roy C. Lester	Marshall Space Flight Center
Mission Scientist	Eugene W. Urban	Marshall Space Flight Center
Lead Payload Operations	Axel Roth Director	Marshall Space Flight Center

COMMUNICATIONS AND DATA HANDLING

For any successful Shuttle mission, the ground control team must be able to track the spacecraft, communicate with the astronauts and command the orbiter. These capabilities allow them to oversee the condition of the spacecraft and its crew.

The Spacelab 2 mission is more complex than many other Shuttle missions because vast amounts of data must be collected from the various experiments. To accommodate the need for additional information, a unique communications and data handling network has been established for Shuttle/Spacelab missions.

NASA handles 51-F/Spacelab 2 tracking and communications through the Tracking and Data Relay Satellite System (TDRSS) and the Ground Space Tracking and Data Network (GSTDN) of 11 ground radar stations that can communicate with a spacecraft when it is in view. TDRSS and GSTDN link the Shuttle/Spacelab to Johnson Space Center and Goddard Space Flight Center.

During the Spacelab 2 mission, TDRSS will be used to relay commands and data to and from the experiments aboard Spacelab 2. The GSTDN will supplement TDRSS and provide routine, real-time tracking and communications with the Shuttle orbiter and its crew.

The NASA Communications Network (NASCOM), managed by Goddard, provides the voice and data communications links connecting the network. During the flight, Spacelab 2 data flow from the Shuttle orbiter to TDRS-1, which transmits to the TDRSS ground station at White Sands, NM. The data could also flow from the orbiter to one of the GSTDN stations. In either case, the data are transmitted to a commercial satellite which sends the data to the Spacelab data processing facilities at the Goddard and Johnson centers.

The data sent to the Johnson Center are usually in the form of computer readouts or video. Investigator teams working around-the-clock at work stations in the Johnson control center can analyze these data real-time. Data received during the early phase of the mission may help them plan observations or experiments for the rest of the flight.

The Spacelab Data Processing Facility (SLDPF) at Goddard was developed specifically to handle the large volume of science data transmitted from Spacelab to the ground. The Goddard data facility separates and records data by experiment. After the mission, this facility distributes data to each investigator. The data may be in varied forms, such as video tapes, computer tapes or audio tapes. The facility also records data from other Shuttle payloads that use the onboard data system.

Huntsville Operations Support Center

The Huntsville Operations Support Center (HOSC), located at Marshall Space Flight Center, monitors the Shuttle during prelaunch and launch at Kennedy Space Center and supports Johnson Space Center by monitoring Spacelab 2 systems and payload operations during the mission.

During the 51-F premission testing, countdown and launch, real-time data are transmitted from the Shuttle to consoles in the HOSC, which are manned by Marshall and contractor engineers. They evaluate and help solve any problems that occur with Marshall-developed Space Shuttle propulsion system elements, including the main engines, external tank and solid rocket boosters. They also monitor the overall main propulsion system and range safety system.

During the 7-day mission, support center personnel monitor the Spacelab systems' temperatures, pressures, electrical measurements and onboard computer system. HOSC scientists and engineers view onboard crew activities via closed-circuit television, monitor air-to-ground communications and monitor experiment and systems computers and IPS performance. If a problem is detected, the appropriate individuals in the Spacelab action center are notified. The information is then relayed to the Payload Operations Control Center and Flight Control Room within the Mission Control Center at Johnson.

STS-51F CREWMEMBERS

S85-29307 -- Portrait of the STS 51-F crew. Mission commander Gordon Fullerton is seated with pilot Roy Bridges beside him. From left to right are mission specialists Anthony England, Karl Henize and Story Musgrave and payload specialists Loren Acton and John-David Bartoe.

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BIOGRAPHICAL DATA

C. GORDON FULLERTON, 48, Colonel, USAF, is mission commander. Born in Rochester, NY, he became a NASA astronaut in 1969. He received bachelor of science and master of science degrees in mechanical engineering from the California Institute of Technology.

Fullerton entered active duty with the Air Force in 1958. He underwent combat crew training and then attended the USAF Aerospace Research Pilot School.

He served as support crew member for the Apollo 14 and 17 missions. He also served as pilot on the critical orbiter flight tests in 1977. He logged 192 hours as pilot in space on STS-3, the third orbital test flight of the Shuttle.

ROY D. BRIDGES JR., 41, Colonel, USAF, is pilot. A native of Gainesville, GA, he graduated from the U.S. Air Force Academy with a bachelor of science degree. He received a master's degree in astronautics from Purdue University.

Bridges trained as a fighter pilot and flew combat missions in Vietnam. In 1970, he attended the USAF Test Pilot School and was a research engineering test pilot until 1974.

Bridges was selected as a NASA astronaut candidate in 1980. He served as primary entry communicator for STS-5 and STS-6, as well as primary ascent communicator for STS-7. He has logged more than 3,375 hours of flying time; Spacelab 2 is his first space flight.

ANTHONY W. ENGLAND, 43, Ph.D., a mission specialist, was selected as a scientist astronaut in 1967. He served as a support crew member for the Apollo 13 and 16 flights.

England received bachelor and master of science degrees in geology and physics from the Massachusetts Institute of Technology. In 1970, he received a doctorate in planetary sciences from MIT. He has continued his geophysics research all around the United States and in Antarctica.

After serving as a research geophysicist for the U.S. Geological Survey for 7 years, England returned to Johnson Space Center as a senior mission specialist in the operations mission development group of the astronaut office. He has logged more than 2,000 hours in flying time.

KARL G. HENIZE, 58, Ph.D., is a mission specialist. Selected as a scientist astronaut in 1967, he has conducted extensive astronomical observations and research using both Earth-based observatories and orbiting instruments.

Henize received a bachelor of arts degree in mathematics and a master of arts degree in astronomy from the University of Virginia, and a doctorate in astronomy from the University of Michigan. He was a member of the astronaut support crew for the Apollo 15 and the Skylab 2, 3 and 4 missions.

He has logged 1,900 hours flying time in jet aircraft.

BIOGRAPHICAL DATA

F. STORY MUSGRAVE, 49, MD, from Lexington, Ky., is a mission specialist with certain flight responsibilities. He was selected as an astronaut in 1967. Since that time he has worked with NASA on projects such as Skylab design and development and on the development of Shuttle EVA equipment.

Musgrave received a bachelor of science degree in mathematics and statistics from Syracuse University, a master of business administration degree in computer programming from the University of California at Los Angeles, a bachelor of arts degree in chemistry from Marietta College, a doctorate in medicine from Columbia University, and a master of science in physiology and biophysics from the University of Kentucky.

Musgrave has logged more than 13,200 hours flying time in both civilian and military aircraft. He also served as mission specialist on STS-6.

LOREN W. ACTON, 48, Ph.D., is a payload specialist and solar physics expert. Born in Lewiston, Mont., Acton is the senior staff scientist with the Space Sciences Laboratory, Lockheed Palo Alto Research Laboratory, Palo Alto, CA.

Acton received a bachelor of science degree in physics from Montana State University and a doctorate in solar physics from the University of Colorado at Boulder. He has been involved in solar physics and high-energy astrophysics research on many NASA projects. He also is a co-principal investigator for an instrument aboard the Solar Maximum Mission spacecraft.

Acton is a co-investigator for the Spacelab 2 Solar Magnetic Field and Velocity Measurement (SOUP) experiment.

JOHN-DAVID F. BARTOE, 41, Ph.D., is a payload specialist and astrophysics expert. He received a bachelor of science degree in physics from Lehigh University, and a master of science degree and a doctorate in physics from Georgetown University.

Bartoe is currently an astrophysicist at the Naval Research Laboratory in Washington, DC, where he has performed solar research for almost 20 years. He has carried out solar ultraviolet studies with sounding rockets, satellites, and instruments flown on Apollo and Skylab missions.

Bartoe is a co-investigator on the Solar Ultraviolet High Resolution Telescope and Spectrograph (HRTS) experiment and the Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) experiment.

EUROPEAN SPACE AGENCY

With the ratification of its convention, Oct. 30, 1980, the European Space Agency (ESA), which de facto came into being in May 1975, acquired its legal existence. The agency groups in a single body the complete range of European space activities previously conduced by ESRO (European Space Research Organization) and ELDO (European Launcher Development Organization) in their respective fields of satellite development and launcher construction.

The 11 member states of ESA are: Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom. Three other are closely associated with the agency: Austria and Norway have associate member status and Canada has an agreement for close cooperation.

The agency's purpose, as described in its convention, is to provide for and to promote, for exclusively peaceful purposes, cooperation among European states in space research and technology, and their space applications, with a view to their being used for scientific, technical, administrative and financial matters, each state having one vote (but none in the case of an optional program in which it is not participating).

The chief executive and legal representative of the agency is the Director General who is appointed by the Council for a defined period.

ESA Headquarters is located in Paris and has a staff of some 280 people. Its main technical center, ESTEC, the European Space Research and Technology Center, with a staff of about 780 people, is located at Noordwijk, the Netherlands. Its Space Operations Center (ESOC) is located at Darmstadt, Federal Republic of Germany. Another center, ESRIN, in Frascati, near Rome, houses the Information Retrieval Service and the Earthnet Program Office. The agency also has a liaison office in Washington, DC.

ESA INDUSTRIAL ORGANIZATION

Contractors to ESA (for Spacelab development)

Prime Contractor

VFW-Fokker ERNO (now MBB-ERNO)	Federal Republic of Germany	Project management, system, engineering, product assurance, integration, test operations, thermal control, miscellaneous Spacelab components and services

Co-contractors

AEG Telefunken Industries	Federal Republic of Germany	Electrical power distribution
Aeritalia	Italy	Module structure, environmental and thermal control subsystem
Bell Telephone Manufacturing Co.	Belgium	Electrical systems ground support subsystem (system level)
Dornier Systems	Federal Republic of Germany	Environmental control/life subsystem
Fokker	The Netherlands	Scientific Airlock, common payload support equipment
British Aerospace	United Kingdom	Pallet structure
Kampsax	Denmark	Computer software
Matra	France	Command and data management subsystem
Sabca	Belgium	Igloo structure, utility bridge, common payload support equipment
Sener	Spain	Mechanical ground support equipment

Subcontractors

AEG-ULM	Federal Republic of Germany	Intercom system and electrical harness
Aeritalia	Italy	Airlock manufacturing and handling equipment
Brunswick	United States	Nitrogen tank assembly
Brunswick/Celesco	United States	Fire and smoke detector, fire suppression system
Carleton	United States	Hybrid system, atmospheric control assembly
Casa	Spain	Mechanical ground support equipment items
CII	France	Computers and software
Compagnie Industrielle Radio Electronique	Switzerland	Simulators, orbiter interface adapter
Dornier Systems	Federal Republic of Germany	Subsystem computer operating system coding
Draeger	Federal Republic of Germany	Ground support equipment for environmental control life support
Elec. Zentr.	Denmark	Pressure decay sensor
ERNO	Federal Republic of Germany	Condensate storage assembly
ETCA	Belgium	Measuring and stimuli equipment
Hamilton Standard	United States	Fan assembly, water separator, CO2 control assembly, humidity and temperature control assembly, pumps
Instituto Nacional de Technica (INTA)	Spain	Mechanical ground support equipment, lighting
Martin Marietta	United States	Demultiplexer
MBB	Federal Republic of Germany	Multiplexer
Microtechnica	Italy	Thermal control system components, pump package
Nord Micro Elektronix	Federal Republic of Germany	Avionics assembly

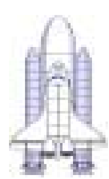
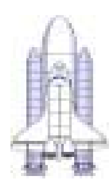
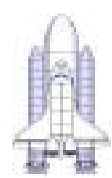
Odetics	United States	Digital recorder, mass memory
OKG (later replaced by VMW)	Austria	Mechanical ground support equipment, viewport adapter assembly, manifolds, nitrogen shut-off valve control
Rovsing	Denmark	Computer software
Standard Electric Lorenz (SEL)	Federal Republic of Germany	Remote acquisition units, caution and warning system
Terma	Denmark	Subsystem power distribution box
Thompson CSF	France	Data display system
Vereinigte Flugtechnische Werke (VFW)	Federal Republic of Germany	Mechanical ground support equipment

Consultants

McDonnell Douglas and TRW	United States	Instrument Pointing System
Dornier Systems	Federal Republic of Germany	Prime Contractor

SHUTTLE FLIGHTS AS OF JULY 1985

18 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM

	STS-51B 04/29/85 - 05/06/85	
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	
STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51G 06/17/85 - 06/24/85
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84	STS-51D 04/12/85 - 04/19/85
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83	STS-51C 01/24/85 - 01/27/85
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83	STS-51A 11/08/84 - 11/16/84
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83	STS-41D 08/30/84 - 09/05/84
OV-102 Columbia (6 flights)	**OV-099 Challenger (7 flights)**	**OV-103 Discovery (5 flights)**